CoA/M/M+P-32

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THE COLLEGE OF AERONAUTICS

DEPARTMENT OF PRODUCTION AND INDUSTRIAL ADMINISTRATION

Test Report No. PLBO/12

Comparison of modified forms of PERPRO carbide grade TO 348 when machining EN 9.

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SUMMARY

Tools of TO 348/ RD60, RD61, RD62, RD63 and Standard were tested to 0.030 in. flankwear when machining EN 9 at 600 fpm with 0.010 in/rev. feed and 0.10 in. depth of cut. The results showed that while no one grade was outstanding RD61, RD62 and RD63 gave an all round better performance than the other two grades.

28913

Test Conditions

The conditions for the tests were:-

Cutting speed	600 fpm
Feed	0.010 in/rev.
Depth of cut	0.10 in.
Material	EN 9

and the tools used were:-

T0348/RD60	NT 81, 82, 83, 84, 85.
T0348/RD61	NT 87, 88, 90.
T0348/RD62	NT 93, 94, 95.
T0348/RD63	NT 160, 161.
T0348/STD	NT 166, 167.

Test results

The flankwear of the tools was measured as shown in figure 1 at intervals of three minutes cutting time and the results are recorded in tables 1-15.

The growth of the flankwear for each grade of tool is shown in figures 2-6. For purposes of comparison the spread of the tool life to .030 in. flankwear for the five grades is shown together in figure 7. Tallysurf traces of the crater wear are shown in figure 8. Photographs of the tools at the end of the test are shown in figures 9-18.

From figure 7 it can be seen that RD62 gave the best mean tool life and that RD60 gave the most variation between tips.(One tip of this grade gave a life of 76 mins compared with the mean life of 36 min. - see fig. 2.) Figure 8 shows that although RD61 gave the least crater wear there was not a great difference between the four modified grades; all of them being better than the standard grade. The photographs show that RD63 gave the most uniform flankwear.

Conclusions

The results show that for test conditions investigated RD61, 62 and 63 gave much the same overall performance taking into account tool-life, crater wear and variability. RD60 and the standard tools did not perform so well as the other three grades.

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Table 1

Tool: NT 81
Material: EN 9
Feed: 0.010 in/rev.

Cutting speed: 600 fpm
Depth of cut: 0.10 in.
Date: 17/11/63

TIME min.	FLANKWEAR Fa	Fb	Fc	DEFORM-ATION	HARDNESS vhn	REMARKS
3	.003	.0035	.0025		260	
6	.004	.0045	.007			
9	.004	.0045	.010			
12	.006	.0065	.014			
15	.006	.0065	.017	.0005		
18	.006	.007	.021	.0005		
21	.007	.0085	.026	.0005		
24	.008	.010	.028	.001		
27	.010	.011	.030	.001		
30	.0115	.0145	.030	.0025		
33	.012	.0165	.0305	.003		

Table 2

Tool: NT82
Material: EN 9
Feed: 0.010 in/rev.

Cutting speed: 600 fpm
Depth of cut: 0.10 in.
Date: 17/11/63

TIME min.	FLANKWEAR Fa	Fb	Fc	DEFORM-ATION	HARDNESS vhn	REMARKS
3	.003	.0035	.0025		260	
6	.0045	.0035	.009			
9	.005	.005	.0095		242	new bar
12	.006	.0065	.0095	.001		
15	.0065	.007	.0125	.001		
18	.0075	.0075	.0135	.001		
21	.0085	.0085	.0165	.001		
24	.0085	.010	.0165	.0015		
27	.0105	.011	.0205	.0015		
30	.0105	.011	.021	.0015		
33	.0105	.0125	.022	.0015		
36	.0115	.0135	.0235	.0015		
39	.0125	.015	.025	.0015	245	new bar
42	.0125	.015	.029	.002		
45	.0135	.016	.035	.002		

Table 3

Tool: NT83
Material: EN 9
Feed: 0.010 in/rev.

Cutting speed: 600 fpm
Depth of cut: 0.10 in.
Date: 25/11/63

TIME min.	FLANKWEAR Fa	Fb	Fc	DEFORM-ATION	HARDNESS vhn	REMARKS
6	.0045	.0045	.006		253	
12	.005	.005	.009			
18	.006	.007	.011			
24	.0075	.0085	.0145	.0005		
30	.009	.0105	.0175	.001		
36	.009	.0105	.020	.001		
42	.012	.013	.020	.001	272	new bar
48	.013	.015	.021	.0015		
54	.014	.016	.022	.0015		
60	.014	.016	.023	.002		
66	.014	.0165	.024	.0025		
72	.014	.017	.027	.0025		
78	.016	.018	.032	.003		

Table 4

Tool: NT84
Material: EN 9
Feed: 0.010 in/rev.

Cutting speed: 600 fpm
Depth of cut: 0.10 in.
Date: 10/12/63

TIME min.	FLANKWEAR Fa	Fb	Fc	DEFORM-ATION	HARDNESS vhn	REMARKS
6	.005	.005	.008		254	
12	.006	.006	.012			
18	.008	.008	.018	.0005		
24	.0085	.009	.024	.001		
30	.0105	.0115	.028	.0015		
36	.012	.013	.029	.002		
42	.0135	.014	.0025	.0025		

Table 5

Tool: NT 85
Material: EN 9
Feed: 0.010 in/rev.

Cutting speed: 600 fpm
Depth of cut: 0.10 in.
Date: 10/12/63

TIME min.	FLANKWEAR Fa	Fb	Fc	DEFORM-ATION	HARDNESS vhn	REMARKS
6	.004	.004	.0085		254	
12	.005	.005	.014			
18	.008	.0085	.022	.001		
24	.008	.0085	.024	.0015		
30	.010	.0105	.028	.002		
36	.010	.0115	.029	.002		
42	.0125	.014	.030	.002		

Table 6

Tool: NT 87
Material: EN 9
Feed: 0.010 in/rev.

Cutting speed: 600 fpm
Depth of cut: 0.10 in.
Date: 17/11/63

TIME min.	FLANKWEAR Fa	Fb	Fc	DEFORM-ATION	HARDNESS vhn	REMARKS
3	.003	.003	.005		245	
6	.005	.005	.008			
9	.005	.005	.009	.0005		
12	.0055	.0055	.0115	.001		
15	.007	.007	.014	.001		
18	.0085	.012	.018	.001		
21	.0085	.0135	.019	.001		
24	.011	.015	.019	.0015		
27	.013	.016	.020	.002		
30	.015	.018	.022	.002		
33	.016	.0195	.023	.002	245	new bar
36	.016	.020	.0235	.002		
39	.016	.022	.027	.002		
42	.017	.022	.029	.002		
45	.017	.0225	.0305	.0025		

Table 7

Tool: NT 88
Material: EN 9
Feed: 0.010 in/rev.

Cutting speed: 600 fpm
Depth of cut: 0.10 in.
Date: 17/11/63

TIME min.	FLANKWEAR Fa	Fb	Fc	DEFORM-ATION	HARDNESS vhn	
3	.0035	.005	.005		260	
6	.004	.0075	.009			
9	.004	.0075	.009			
12	.007	.010	.012	.0005		
15	.008	.010	.014	.001		
18	.0095	.010	.018	.001		
21	.010	.0105	.0205	.001		
24	.0105	.011	.021	.0015		
27	.0105	.012	.0225	.0015		
30	.0105	.0125	.0225	.0015		
33	.0105	.013	.023	.002		
36	.014	.017	.024	.0035	242	new bar
39	.0165	.020	.025	.004		
42	.0175	.021	.027	.005		
45	.020	.023	.030	.006		

Table 8

Tool: NT 90
Material: EN 9
Feed: 0.010 in/rev.

Cutting speed: 600 fpm
Depth of cut: 0.10 in.
Date: 25/11/63

TIME min.	FLANKWEAR Fa	Fb	Fc	DEFORM-ATION	HARDNESS vhn	REMARKS
6	.004	.004	.0065	.0005	253	
12	.004	.005	.007	.0005		
18	.006	.007	.011	.0005		
24	.008	.0085	.0145	.001		
30	.009	.011	.0165	.001		
36	.010	.014	.019	.001	272	new bar
42	.010	.014	.025	.0015		
48	.0115	.015	.029	.002		
54	.013	.015	.031	.002		

Table 9

Tool: NT 93
Material: EN 9
Feed: 0.010 in/rev.

Cutting speed: 600 fpm
Depth of cut: 0.10 in.
Date: 17/11/63

TIME min.	FLANKWEAR Fa	Fb	Fc	DEFORM-ATION	HARDNESS vhn	REMARKS
3	.0035	.0035	.005		260	
6	.0035	.004	.008			
9	.0055	.0055	.0095			
12	.006	.008	.012	.0005		
15	.0065	.0085	.0155	.001		
18	.007	.0095	.0175	.001		
21	.0075	.010	.019	.001		
24	.008	.010	.0195	.0015		
27	.0085	.010	.020	.0015		
30	.009	.011	.025	.0015	242	new bar
33	.010	.012	.0265	.0015		
36	.011	.012	.027	.0025		
39	.012	.0155	.027	.0025		
42	.014	.0155	.028	.0025		
45	.0145	.016	.0305	.0025		

Table 10

Tool: NT 94
Material: EN 9
Feed: 0.010 in/rev.

Cutting speed: 600 fpm
Depth of cut: 0.10 in.
Date: 17/11/63

TIME min.	FLANKWEAR Fa	Fb	Fc	DEFORM-ATION	HARDNESS vhn	REMARKS
3	.003	.003	.006		260	
6	.004	.004	.010			
9	.0045	.0045	.010			
12	.0055	.0055	.0105	.0005	245	new bar
15	.0075	.007	.0105	.0005		
18	.0075	.0075	.011	.0005		
21	.008	.0085	.014	.001		
24	.008	.0085	.014	.001		
27	.009	.009	.0165	.0015		
30	.0115	.0135	.019	.0025		
33	.0115	.0135	.019	.0025		
36	.012	.014	.021	.0025		
39	.016	.01555	.022	.0025		
42	.016	.0175	.022	.0025	245	new bar
45	.0175	.020	.022	.0025		
48	.018	.0205	.022	.0025		
51	.018	.022	.026	.0030		
54	.018	.0225	.0265	.0030		
57	.018	.025	.029	.0035		
60	.019	.025	.032	.004		

Table 11

Tool: NT 95
Material: EN 9
Feed: 0.010 in/rev.

Cutting speed: 600 fpm
Depth of cut: 0.10 in.
Date: 25/11/63

TIME min.	FLANKWEAR Fa	Fb	Fc	DEFORM-ATION	HARDNESS vhn	REMARKS
6	.004	.004	.006		253	
12	.005	.005	.008			
18	.0065	.007	.0095	.0005		
24	.0085	.0085	.0115	.001		
30	.0085	.010	.016	.001		
36	.0085	.011	.017	.001	272	new bar
42	.0115	.013	.022	.0015		
48	.012	.014	.026	.002		
54	.013	.0155	.0285	.002		
60	.014	.016	.033	.002		

Table 12

Tool: NT 160
Material: EN 9
Feed: 0.010 in/rev.

Cutting speed: 600 fpm
Depth of cut: 0.10 in.
Date: 15/1/64

TIME min.	FLANKWEAR Fa	Fb	Fc	DEFORM-ATION	HARDNESS vhn	REMARKS
6	.0045	.0045	.005		251	
12	.0055	.0055	.009			
18	.007	.0075	.0135	.0005		
24	.008	.0095	.017	.0075		
30	.009	.0095	.019	.001		
36	.010	.012	.026	.0015		
42	.0125	.014	.030	.002		
48	.0135	.016	.033	.002		

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Table 13

Tool: NT 161
Material: EN 9
Feed: 0.010 in/rev.

Cutting speed: 600 fpm
Depth of cut: 0.10 in.
Date: 23/1/64

TIME min.	FLANKWEAR Fa	Fb	Fc	DEFORM-ATION	HARDNESS vhn	REMARKS
9	.0055	.005	.010	.0005	256	
18	.0065	.006	.014	.001		
27	.009	.010	.018	.001		
36	.0115	.0155	.023	.0015		
45	.017	.020	.0255	.00175		
54	.021	.024	.0285	.00225		
63	.023	.0265	.034	.00225		

Table 14

Tool: NT 167
Material: EN 9
Feed: 0.010 in/rev.

Cutting speed: 600 fpm
Depth of cut: 0.10 in.
Date: 28/2/64

TIME min.	FLANKWEAR Fa	Fb	Fc	DEFORM-ATION	HARDNESS vhn	REMARKS
3	.004	.006	.006		253	
6	.006	.0095	.007			
9	.0065	.010	.0095			
12	.010	.0125	.014			
15	.011	.016	.015	.001		
18	.014	.018	.016	.001		
21	.0145	.020	.0195	.0015	249	
24	.017	.0215	.0215	.0015		
27	.018	.024	.024	.00175		
30	.019	.0255	.0245	.002		
33	.020	.0275	.0265	.002		
36	.0215	.028	.0275	.002		
39	.0215	.028	.0305	.002		

Table 15

Tool: NT 166
Material: EN 9
Feed: 0.010 in/rev.

Cutting speed: 600 fpm
Depth of cut: 0.10 in.
Date: 28/2/64

TIME	FLANKWEAR			DEFORM-	HARDNESS	
min.	Fa	Fb	Fc	ATION	vhn	REMARKS
3	.003	.004	.0065		253	
6	.005	.007	.008			
9	.007	.0105	.009			
12	.010	.013	.0135			
15	.011	.013	.0135	.001		
18	.0115	.016	.016	.001		
21	.013	.0175	.0195	.001		
24	.0135	.019	.0235	.001		
27	.015	.0205	.025	.00125		
30	.016	.0215	.025	.00125		
33	.017	.0225	.028	.00125		
36	.018	.024	.0295	.00175	249	
39	.018	.025	.0315	.00175		

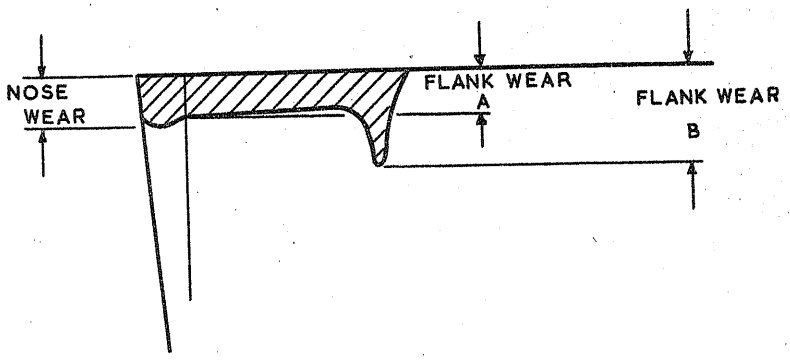


FIG.1. TOOL WEAR MEASUREMENT.

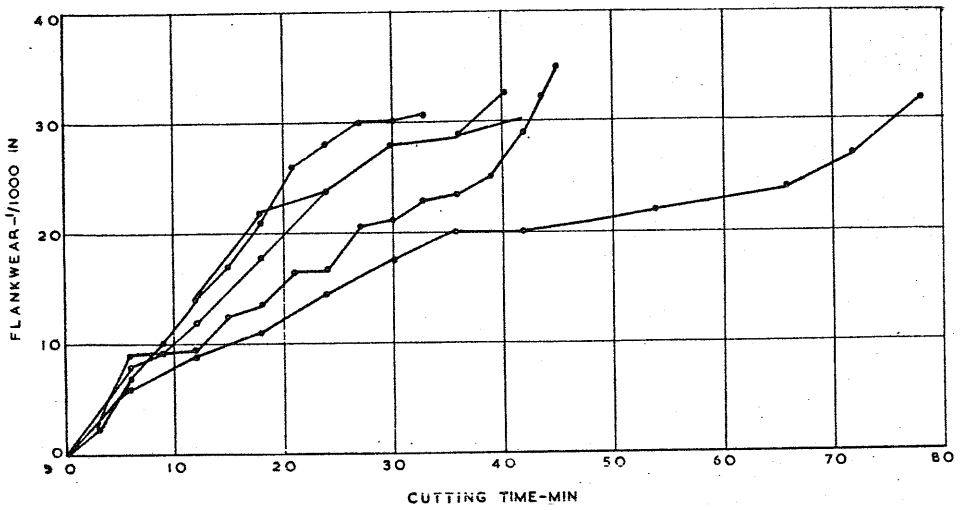


FIG.2. TO348/RD60.

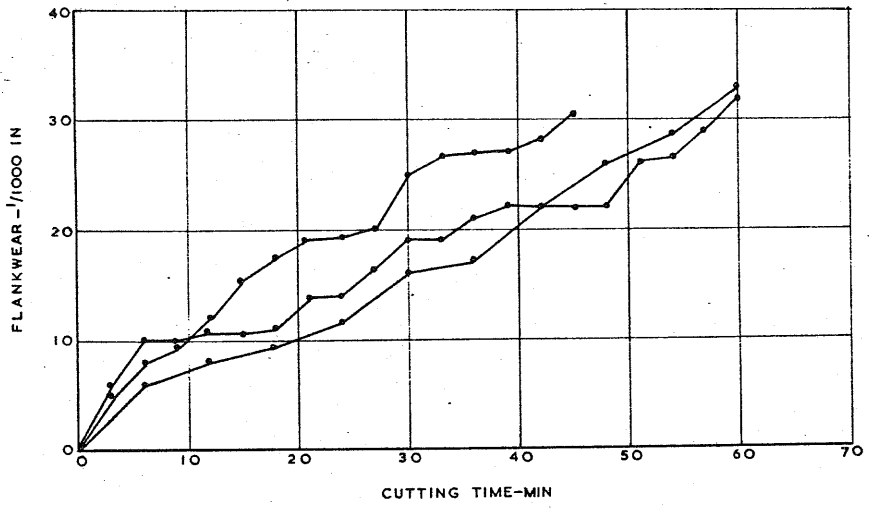


FIG.4. TO348/RD62

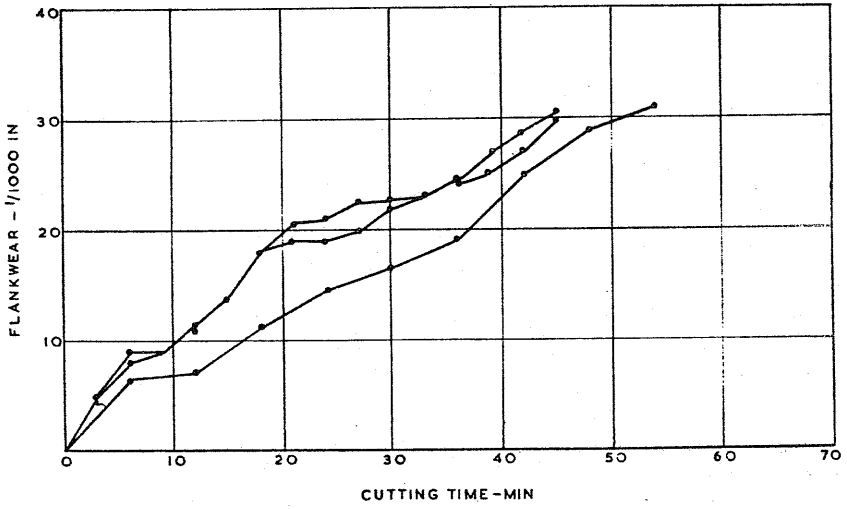


FIG.3. TO348/RD61.

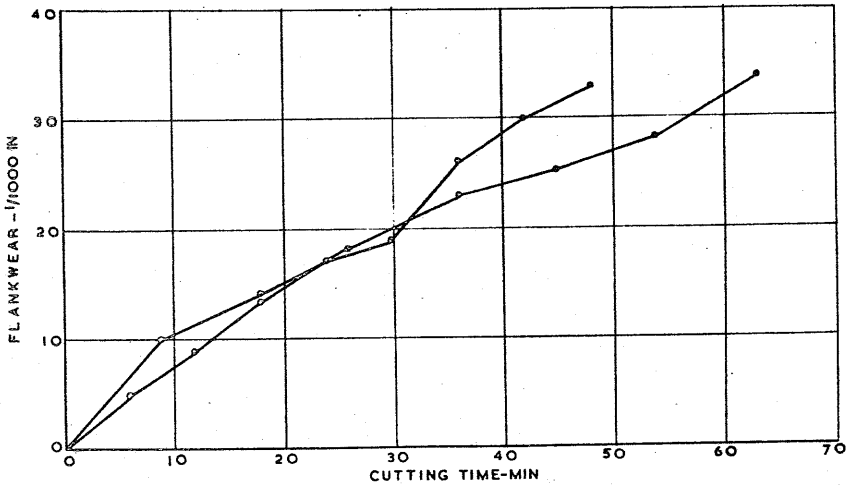


FIG.5. TO348/RD63.

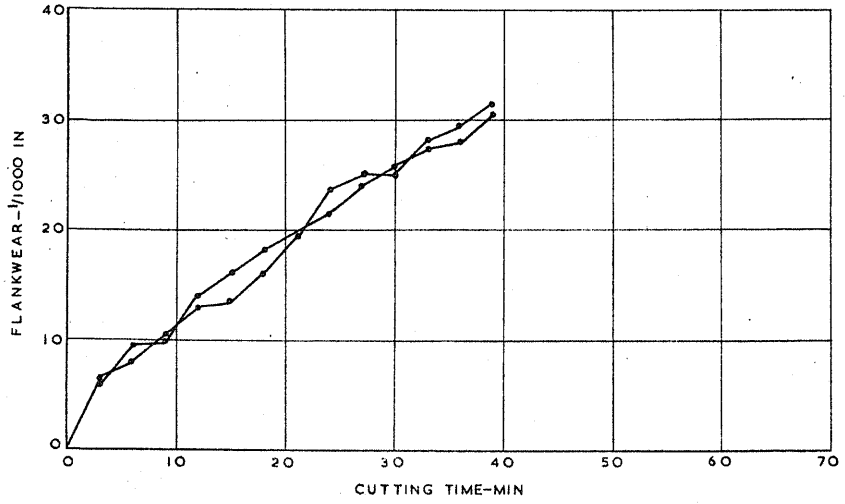


FIG. 6. TO34D/STD.

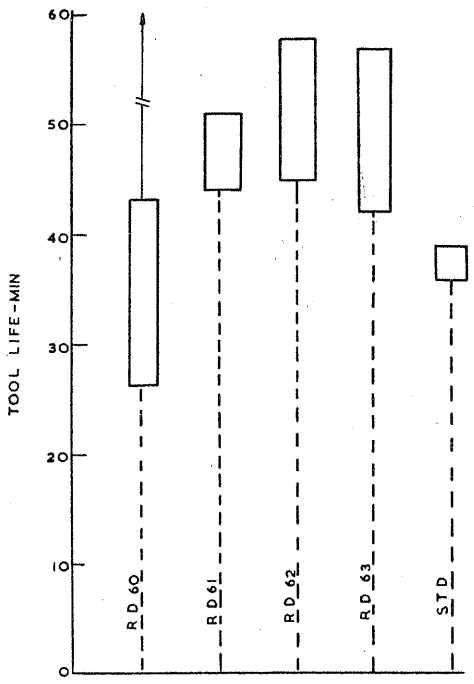


FIG. 7. TOOL LIFE OF MODIFIED GRADES OF TO348.

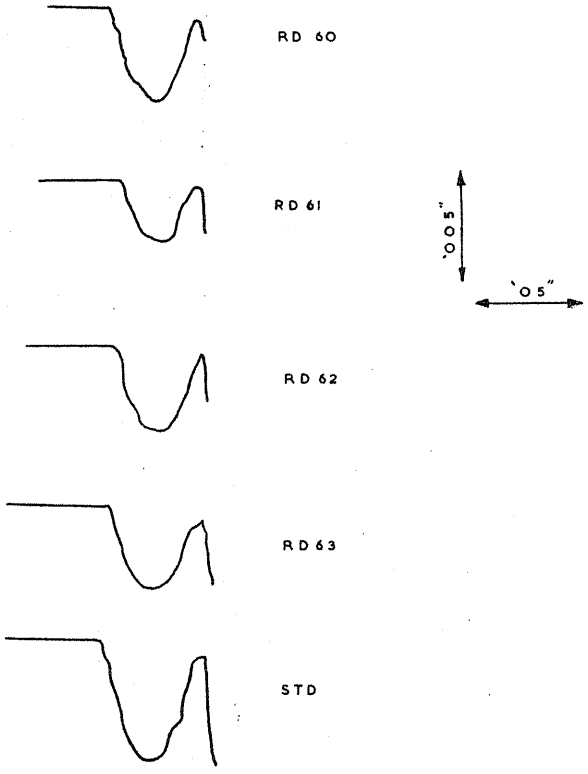
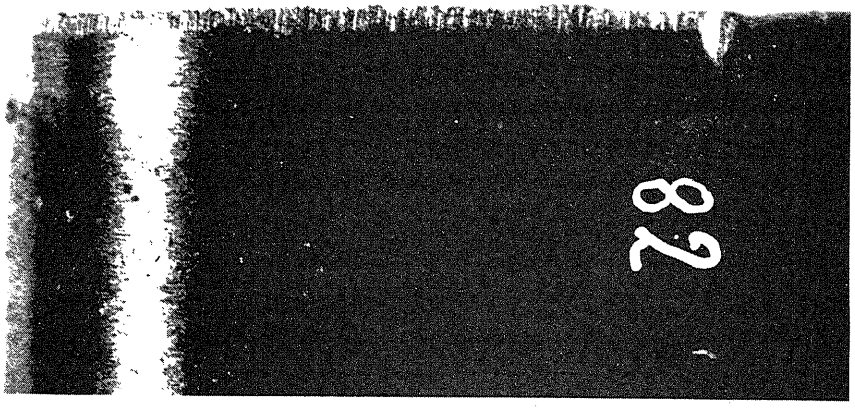
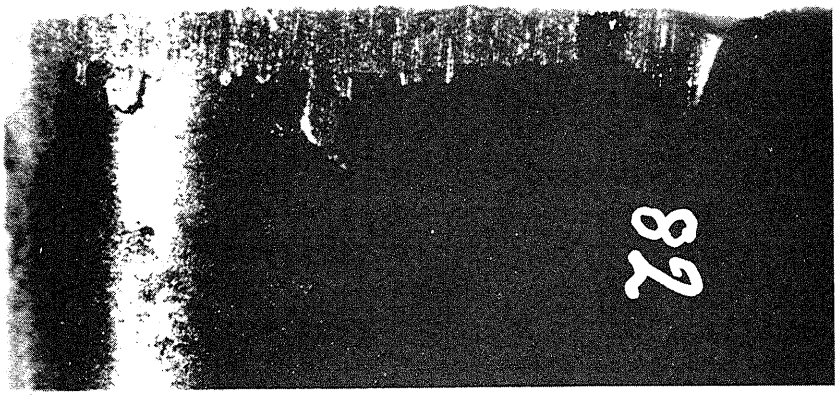


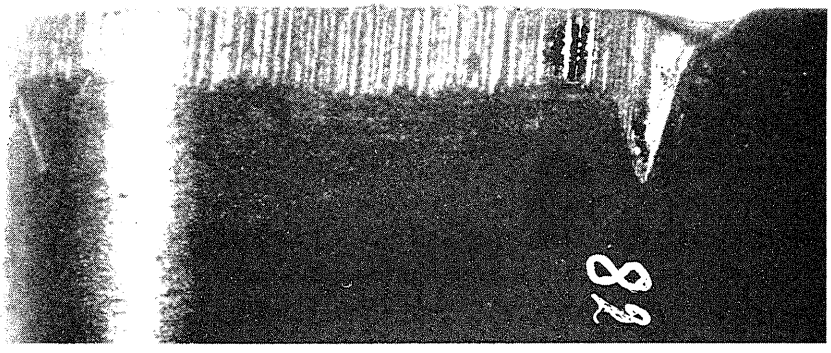
FIG. 8. CRATER WEAR TO348.



A



B



C

Fig. 9 Flankwear grade TO 348/RD60

A .010 in
B .020 in
C .030 in

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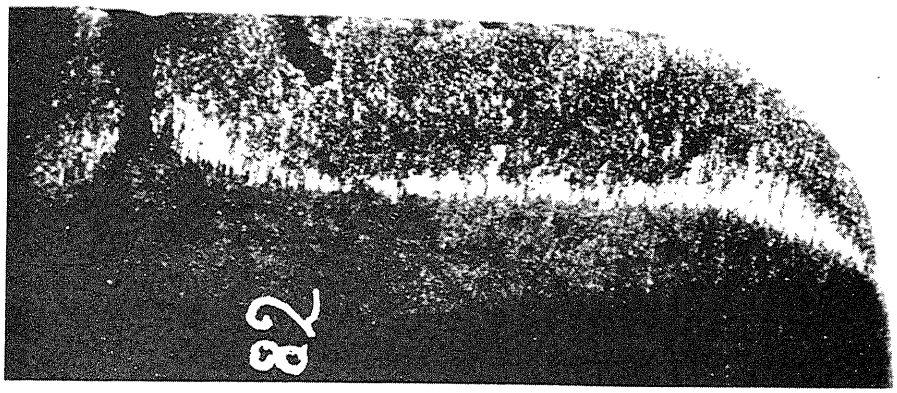
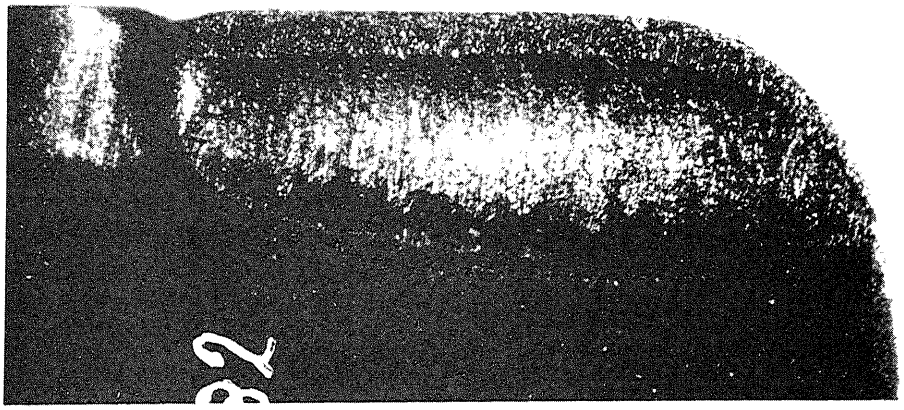
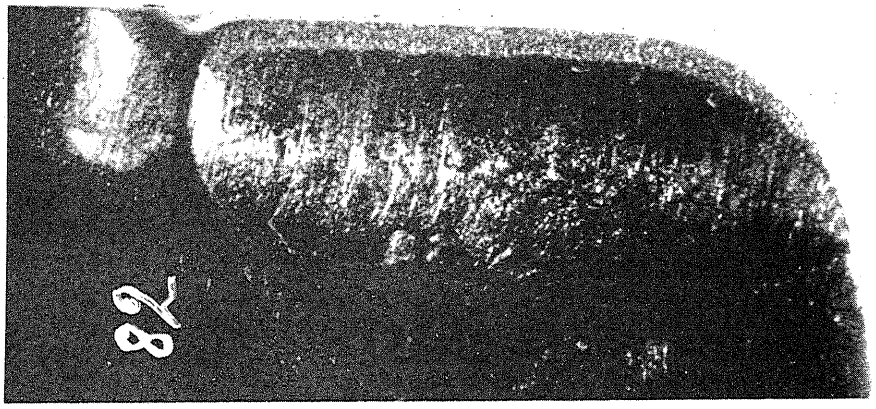


A



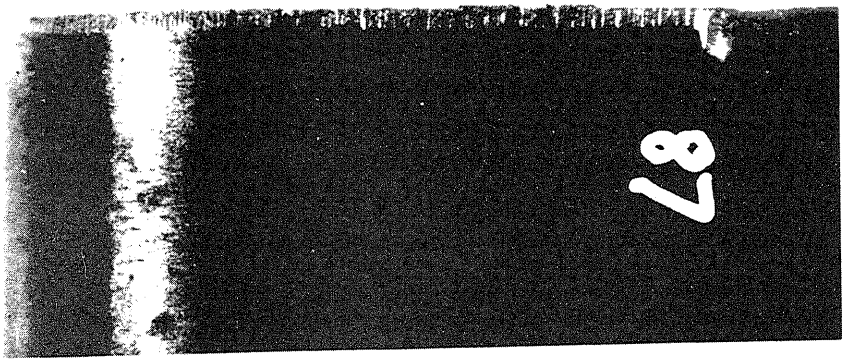
B



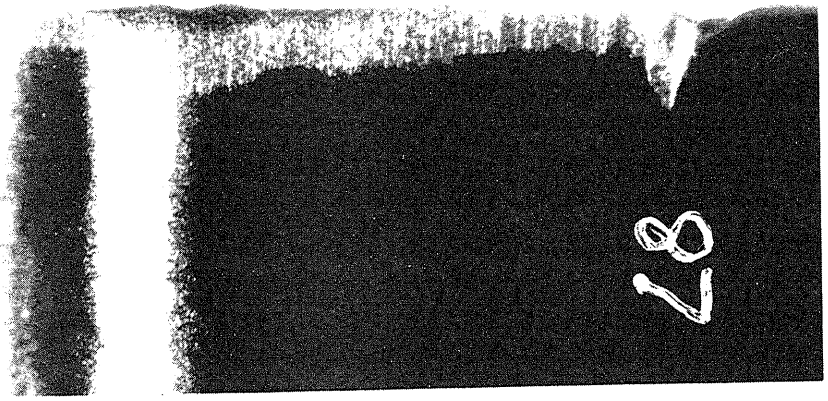
C

Fig. 10 Crater wear grade TO 348/RD 60
corresponding to

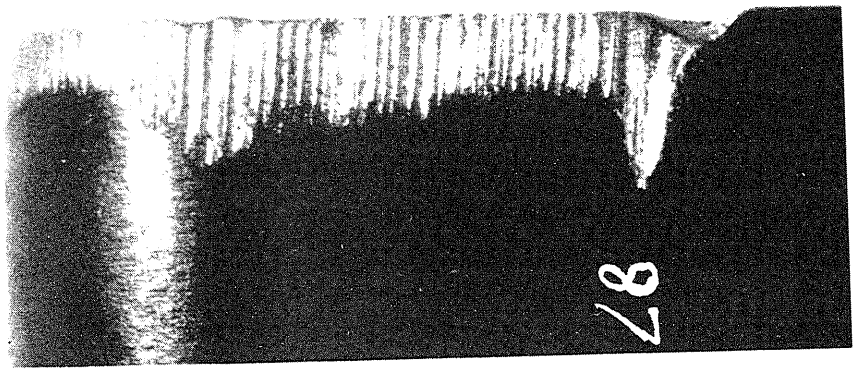
A .010 in flank wear
B .020 in flank wear
C .030 in flank wear



A



B



C

Fig. 11. Flankwear grade TO 348/RD61

A .010 in
B .020 in
C .030 in

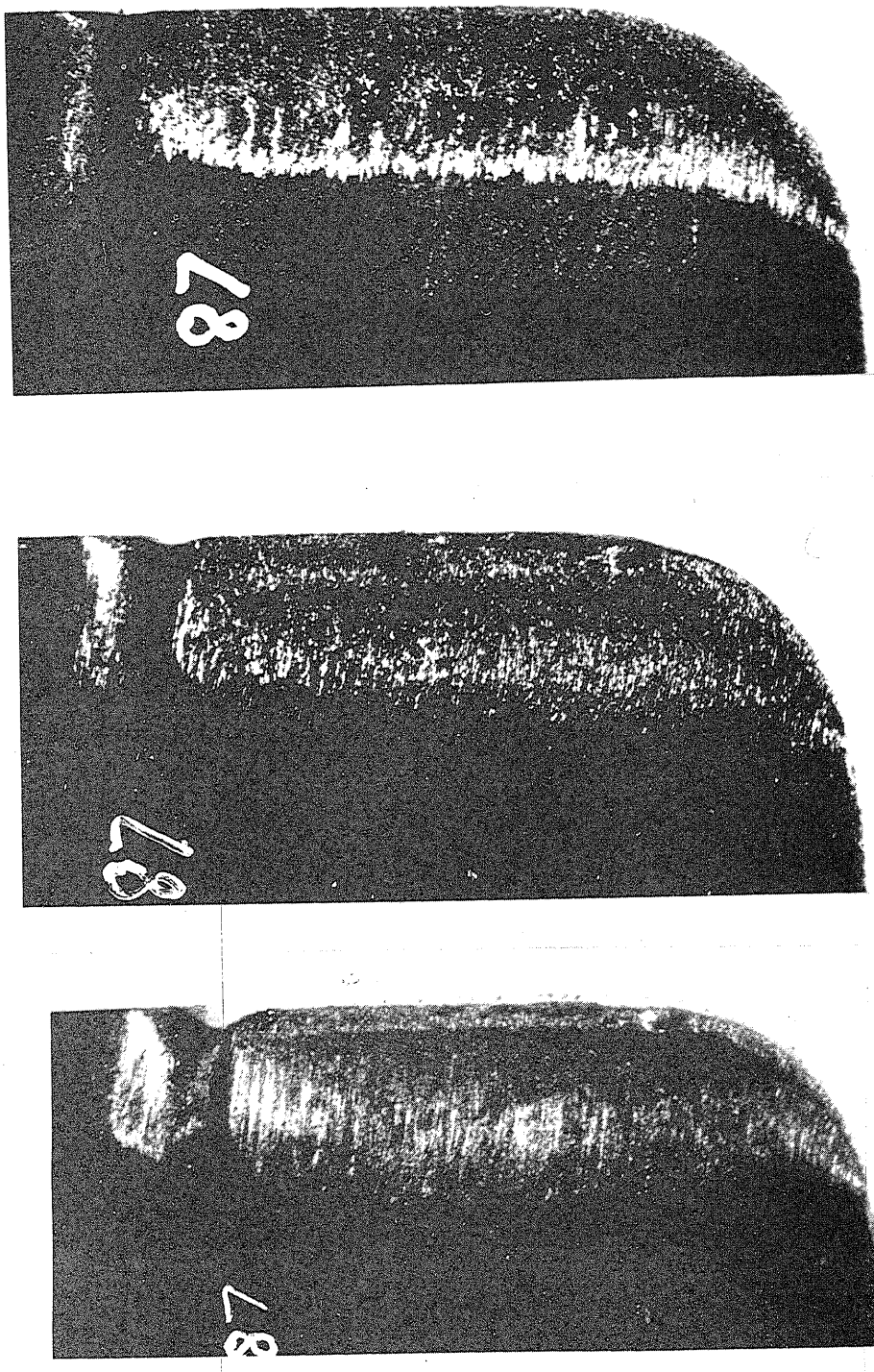
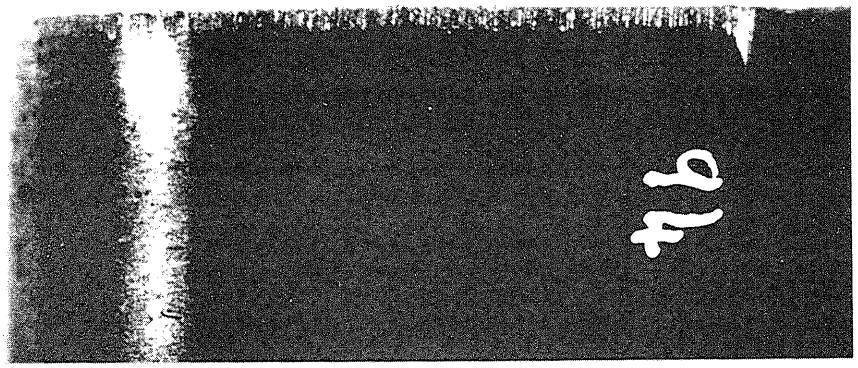
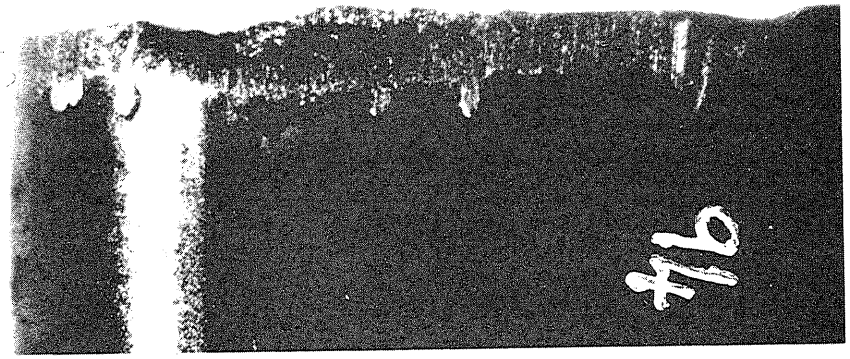


Fig. 12 Crater wear grade TO 348/RD 61
corresponding to A .010 in flank wear
B .020 in flank wear
C .030 in flank wear



A



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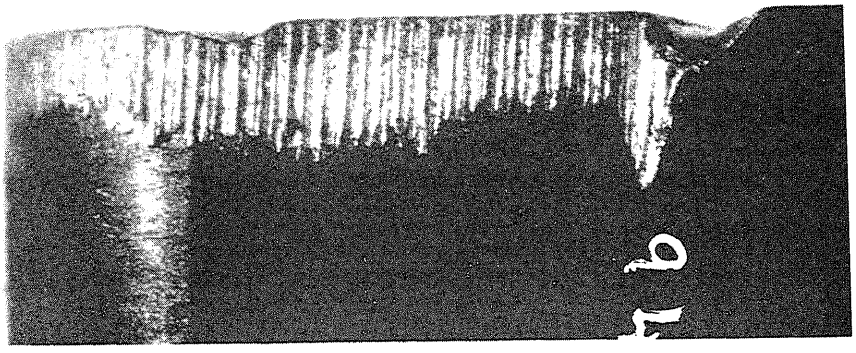
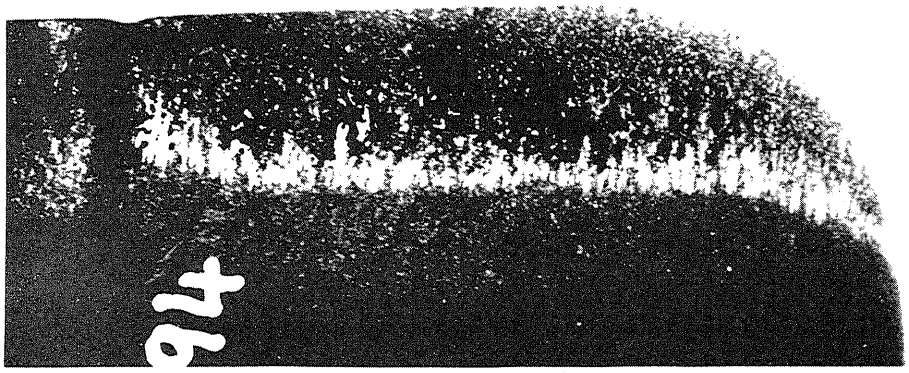


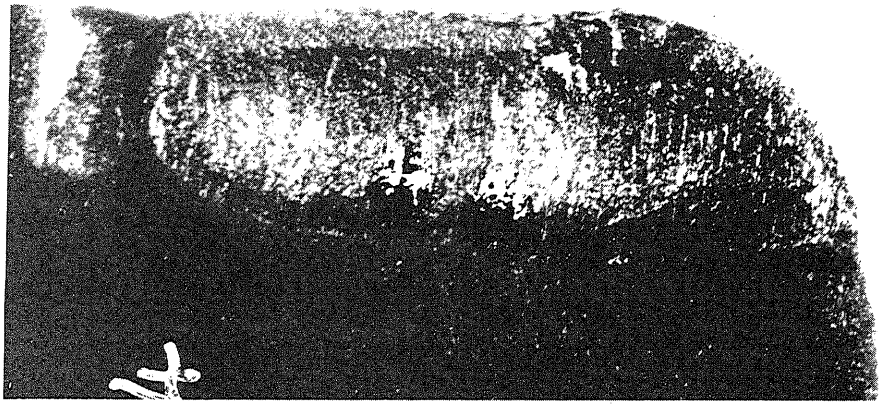
C

Fig. 13 Flankwear grade TO 348/RD 62

A .010 in
B .020 in
C .030 in



A



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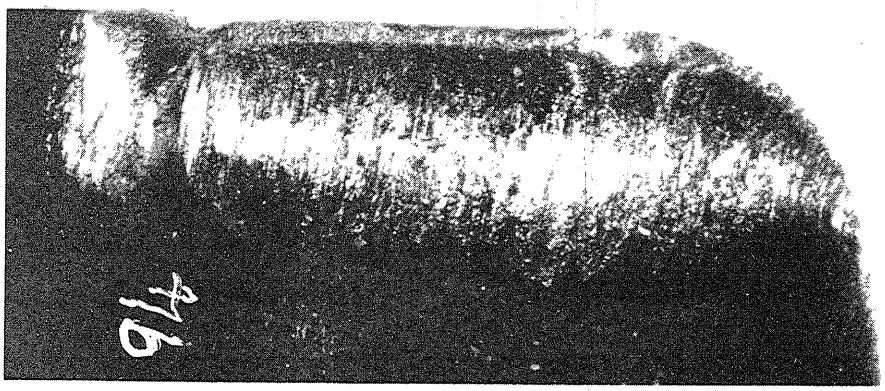
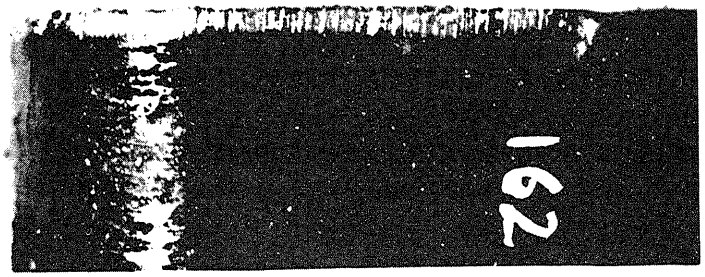


C

Fig. 14 Crater wear grade TO 348/RD 62
corresponding to A .010 in flank wear
B .020 in flank wear
C .030 in flank wear



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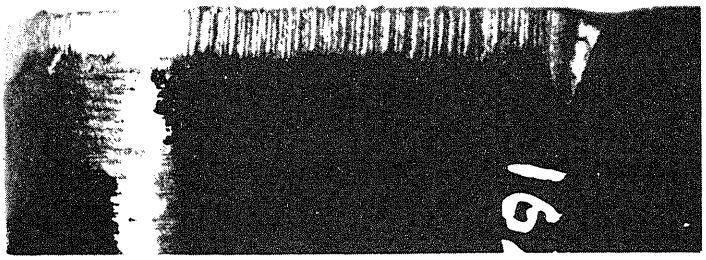

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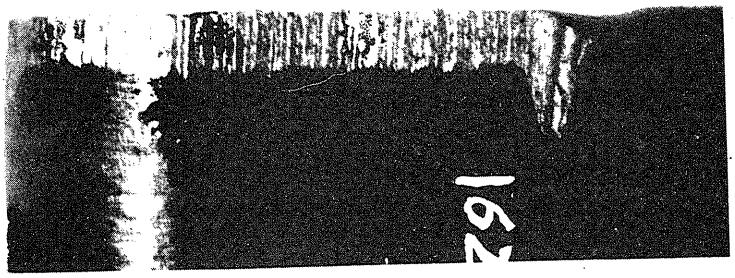

C

Fig. 15 Flankwear grade TO 348/RD63

A	.010 in
B	.020 in
C	.030 in

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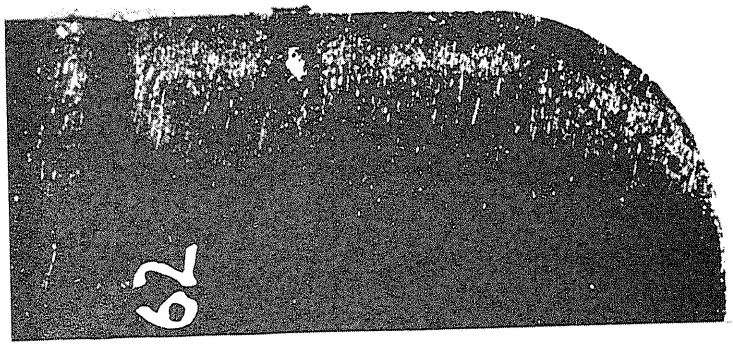
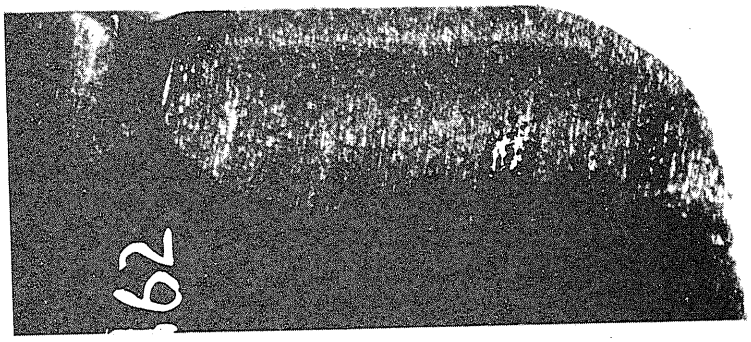


A

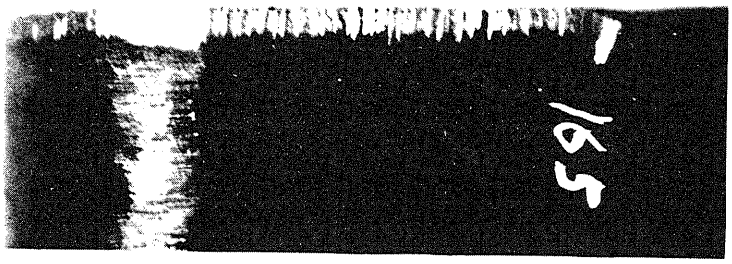


B

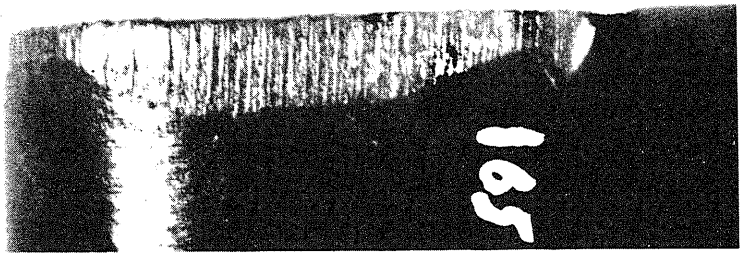
C

Fig. 16 Crater wear grade TO 348/RD63

corresponding to A .010 in flankwear
B .020 in flankwear
C .030 in flankwear



A



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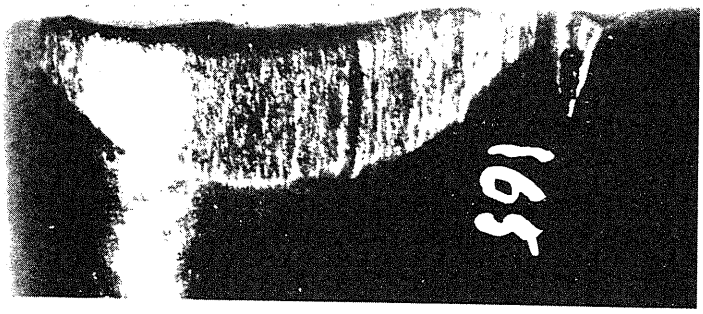
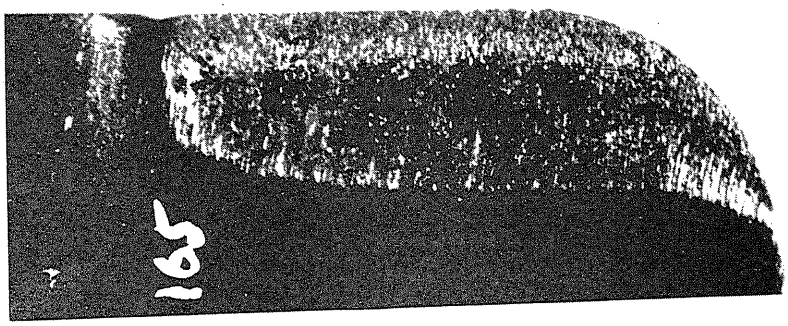


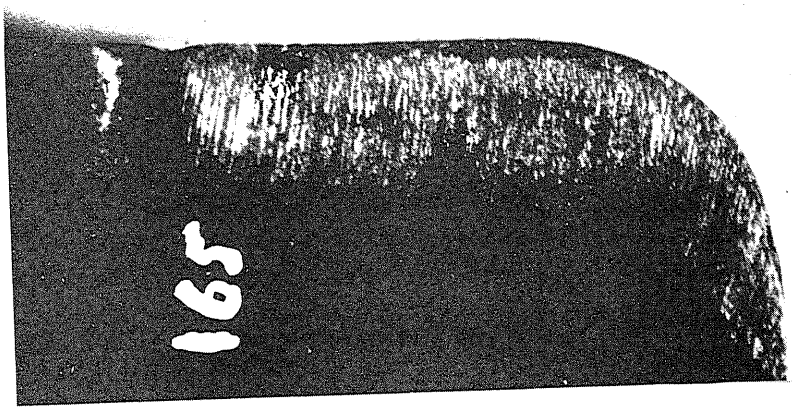
C

Fig. 17 Flankwear grade TO 348/STD

A .010 in
B .020 in
C .030 in



A



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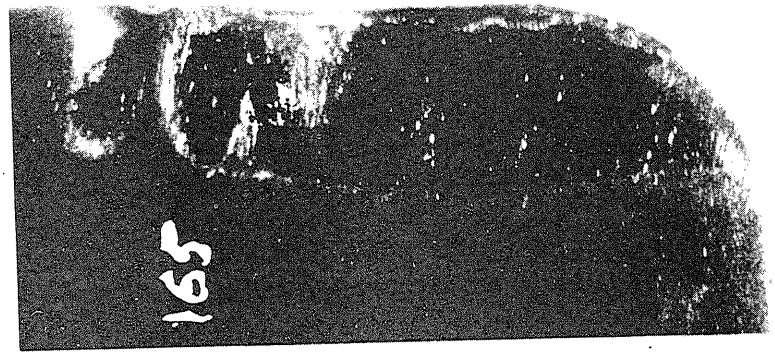

C

Fig. 18 Crater wear grade TO 348/STD

corresponding to A .010 in flankwear
B .020 in flankwear
C .030 in flankwear